Benefit of 19th Booster RF Cavity

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Introduction

Booster RF reliability has been a significant issue, particularly in recent times. In addition to the problems caused by down time, there are extended periods of reduced total RF accelerating voltage. This is a particular concern for slip stacking operation, which requires at least 900 kV/turn for optimum performance.

We are nominally planning a solid state upgrade, which should improve reliability significantly; however, there are a number of RF failures due to problems which will not be solved by this upgrade (damping resistors, water leaks, etc), so it will still be difficult to maintain high RF voltages at all times. Also, the RF upgrade will take some time, and reliable RF is an issue now.

The easiest, most cost effective way to assure 18 working cavities in the Booster is to install 19. Indeed, until recently we had 19 cavities in the Booster, but the 19th was a prototype large aperture cavity that was not particularly useful in assisting the RF system. Now that we've got the space prepared for the cavity, it should be a simple matter to install an ordinary spare of the same type as the other cavities.

In order to be fully useful as a spare, the 19th RF cavity control would have to be modified somewhat to be used with either the A or B RF group in the Booster; however, this is minor on the scale of options being discussed for the Booster RF system.

Analysis

Within statistical errors, the time that we have 18 out of 19 cavities working should be about the same as the time we have 17 out of 18 now. Figure 1 shows the percentage of the time that we have 17 working cavities for each month since we started logging all individual cavity voltages[1]. Note that statistics during all of May and part of April and June are dominated by the fact that cavity 14 went down for 45 days starting on April 22nd because of a water leak - a problem which would not have been ameliorated by the solid state upgrade. Outside of this time, we have been able to maintain at least 17 cavities about 95% of the time.

Figure 2 shows how often the Booster had over 900 kV/turn of accelerating voltage as compared to how often it had over 850 kV/turn. When scaled to 19 cavities, the latter should give an indication of how often we will have greater than 900 kV in a 19 cavity system. The general features of the plot are similar to Figure 1. In particular, in the last few months, after the importance of high accelerating voltages became apparent, we have been able to maintain greater than 850 kV/turn about 95% of the time.

[1] March 9th, 2005

The extended downtime for RF14 was certainly an anomaly that cannot be repeated if maintaining RF power is a priority. Table 1 shows the combined data for the entire logging period, *excluding the time when RF14 was down*. Over the rest of the logging period, we have been able to maintain at least 17 working cavities about 95% of the time. Particular attention should be paid to the second row of the table. This is for the last three months, a period during which Booster RF was given increased priority in response to the recommendation of the Stacking Rapid Response Team. Even so, we have only been able to maintain full RF about 85% of the time. In contrast, this table indicates that had we had 19 cavities, we would have had adequate RF 97% of the time.

Time Period	18 cavities	17 or more cavities	>900 kV/turn	>850 kV/turn
Entire logging period	70.6%	94.2%	66.3%	86.5%
Last three months	85.0%	97.3%	85.9%	97.6%

Table 1: Percentage of time with the Booster in various conditions. The first row is for the entire logging period (excluding the time RF14 was down for a water leak). The second row is for the last three months, during which Booster RF has had increased priority.

Conclusions

Based on operational experience with 18 cavities, adding a 19th cavity to the Booster as a spare should allow us to run with at least 18 working cavities and at least 900 kV/turn more than 95% of the time, as opposed to 85% of the time, which appears to be our maximum now.

Installation of the cavity and the required improvements necessary to make it run with either the A or B Booster RF group should be given a priority appropriate to the importance accorded consistently high RF accelerating voltage in the Booster.

Of course, this solution does not decrease the load on the RF group, so we should continue to pursue the option of the solid state upgrade.

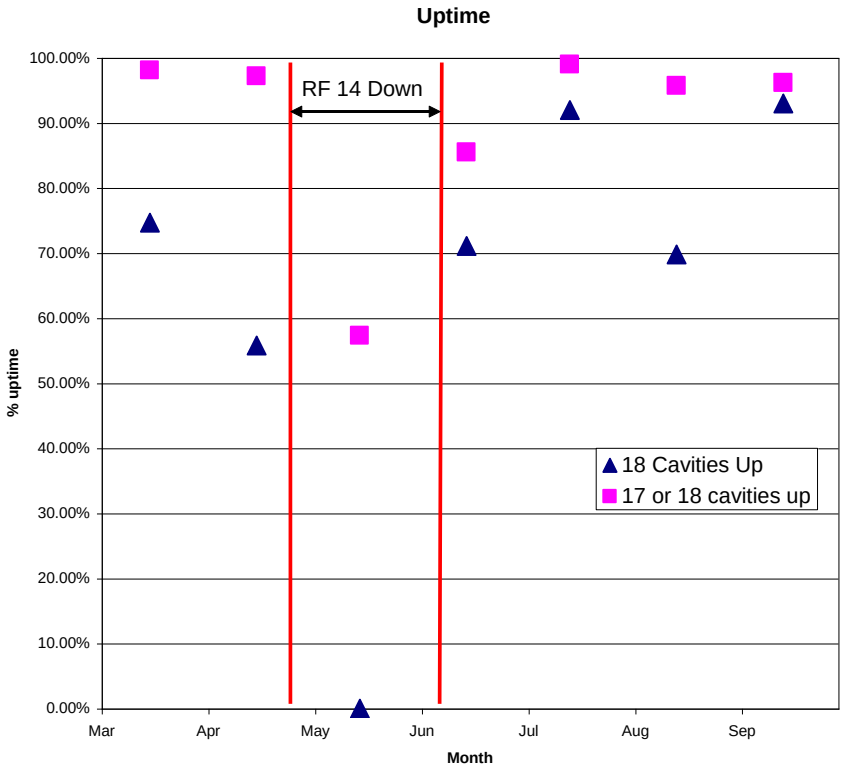

Figure 1: Triangles show fraction of time that the Booster had all 18 cavities at least at 20 kV as a function of month. The squares show the time the Booster had at least 17 cavities.

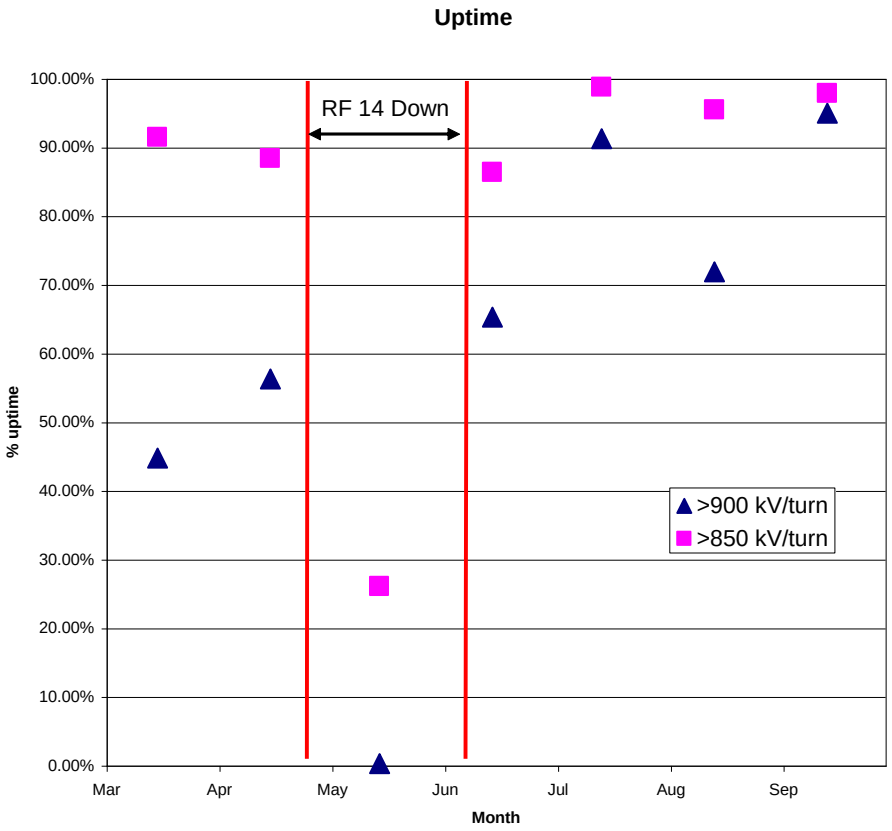

Figure 2: Triangles show fraction of time that the Booster a total accelerating voltage (B:RFSUM) of at least 900 kV/turn. The squares show the time that the Booster had at least 850 kV/turn.